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EDITORIAL

FUNDAMENTAL RESEARCH

KNOWLEDGE may be likened to an edifice which, by the untiring efforts of the craftsmen, steadily but surely grows to perfection.

Again, knowledge may be likened to such a material structure, for although much depends upon the craftsman, its strength and its service to posterity depends upon the soundness of the materials of which it is made. These elements of structure are so interdependent that weakness in one may endanger the whole fabric. Of all these parts the most essential are those on which all the others are laid. These are the foundations.

In the world of science there are foundations; they are the fundamental facts, in other words, the basic knowledge upon which all else depends. In the science of the healing arts many of these fundamental facts have to do with the structure and function of the parts and systems of the animal body. Of much of this we have already a profound knowledge, but in many instances the reverse is the case, and there are great gaps. The work of filling these gaps has not the high allure of research appertaining to the prevention or cure of a particular disease, yet it is of equal importance. It calls for a stricter discipline, great patience and technical skill, and there is less likelihood of the worker gaining notoriety or reward. In the jargon of the war the workers became the "back-room boys" of their particular science.

In this issue we publish an account of the Lymphatic System of the Domestic Fowl which we are sure will meet with the approbation of our readers, particularly those whose work is to investigate disease in that species.

The work has been long, arduous and demanded an infinite capacity for skilful technique and the taking of pains. The author has made a great contribution to our store of knowledge which should be of great service to his fellows.

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NEW AGRICULTURAL RESEARCH COUNCIL APPOINTMENTS

Development of Research in Animal Breeding and Genetics in Great Britain

As part of the survey which the Agricultural Research Council, in conjunction with the Agricultural Improvement Councils for England and Wales and Scotland, have been making of fields of research in which expansion is needed, special attention has been given to animal breeding and genetics as a subject of outstanding importance. After considering advice on developments in this field given to them by a special survey group, for which the U.S.A. Government generously made available the services of Dr. R. T. Clark, of Montana, and after consultation with the Departments of Agriculture, the Agricultural Research Council have appointed to their scientific staff Professor R. G. White, professor of agriculture in the University College of North Wales, Bangor, and Dr. C. H. Waddington, of the Department of Zoology, Cambridge University. Their first task will be to prepare a scheme for the creation of a national organisation for research in animal breeding and genetics, covering the needs of Great Britain.

In this new organisation Professor White will be director and Dr. Waddington chief geneticist.

It will be necessary for Professor White and Dr. Waddington to investigate the systems adopted in other countries for the development of research in this field, so that a complete scheme cannot be ready for some time, though certain investigations of a statistical and fundamental character can be started in the near future. It cannot, of course, be indicated at present what centre or centres will be chosen for the development of research. The Council are, however, anxious that in any new developments full advantage should be taken of the experience of the Institute of Animal Genetics at the University of Edinburgh, which for so long has contributed to knowledge of these subjects and has been the centre of post-graduate training for workers from many countries.

Similarly, it is the Council's intention that by close co-operation with practical breeders and the representatives of the agricultural industry throughout Great Britain, as well as with Milk Marketing Boards and other interested organisations, arrangements shall be made whereby records are kept in such a form as to give the greatest measure of assistance to research workers in the new organisation, and to be of real value in guiding the improvement of livestock.

Research on such slow-breeding animals as farm stock must necessarily be lengthy, and results which can be applied with confidence in breeding practice cannot, therefore, be expected to emerge quickly.

General Articles

THE LYMPHATIC SYSTEM OF THE DOMESTIC FOWL

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THIS paper is a summary of a thesis presented for the degree of Master of Veterinary Science of the University of Liverpool.

Introduction

The lymphatic system in members of the class Aves appears to be in an intermediate stage of development between that in amphibians and reptiles on the one hand and that in mammals on the other. The lymphatics themselves and their valves are relatively few in number when compared with those of the mammal. Lymph hearts, structures which are found in amphibians and reptiles, occur in the embryos of all birds, but disappear before hatching in most species, including the domestic fowl. According to Jolly,[7] lymphatic glands are only present in aquatic birds. Lymphoid tissue, however, is normally present in the substance of certain of the body tissues.

Investigations in the past have been mainly carried out on groups of birds rather than on any given species, and have, as a result, been rather superficial. Owen[10] summarised the findings of his predecessors, and it is Owen's statement which appears to form, directly or indirectly, the basis of the descriptions of the lymphatic system of the domestic fowl in the works of Kaupp[9], Bradley[4] and Sisson.[11] These text-books do not quote from the findings of more recent authors than Owen, as may be seen from the fact that they all maintain that lymphatic glands are present in the fowl, despite the authoritative statements of Jolly.[7]

In 1930, two independent publications appeared which dealt with the lymphatic system of the fowl. One, by Josifoff,[8] a Russian, was concerned mainly with the pigeon, but the other, by Baum,[3] can be said to be the first detailed statement made on this subject.

Because of the general interest of the subject to veterinary science, as well as its special interest in the fields of comparative anatomy and avian pathology, it was felt that an investigation into the anatomy of the lymphatic system of the domestic fowl could profitably be pursued, particularly as an account of such an investigation was not available in English.

Method of Study

In order that the courses of lymphatics may be followed with certainty, it is necessary that they should be filled with some coloured fluid. Direct injection of fluid into lymphatics is rarely possible because of the small calibre of these vessels. Usually an injection is made into the substance of the tissue in question with as fine a needle as possible, and, if the needle has penetrated a tissue space or the commencement of a lymphatic, the lymphatics of the area become filled with injection fluid. Massage of the area of injection is frequently necessary to produce this effect. The technique of injecting lymphatic vessels is admirably discussed in the publications of Gerota,[5] Baum,[2] and Jamieson and Dobson.[6]

The difficulties of lymphatic injection which are encountered in the mammal

are increased in the bird by the fact that the vessels are so small in size and so few in number.

In the present work the injection fluid used was the variant of Gerota's mass described by Baum.[41] This consists of the artists' oil paint "Prussian Blue" mixed to a paste in turpentine and suspended in ether. The needles employed in injection, the finest that the makers could produce, had a diameter of 0.25 mm., and were used with an ordinary Record syringe. Space does not permit a description of the different methods of injection necessary in different tissues, but it may be mentioned that a dissecting microscope was used in following the courses of all but the largest lymphatics.

Report on the Present Investigation

Lymph hearts have not been observed in any fowl which has been examined, even in day-old chicks, but, in some subjects, slight dilatations have been seen on the course of the lymphatics following the middle sacral artery, close to the junction of the sacral and coccygeal regions. This position of these dilatations appears to correspond to the location of lymph hearts in embryo birds and in the adults of those birds in which the structures persist. Lymphatic glands are completely absent in the domestic fowl, and the author agrees with other authors that plexuses of the lymphatics appear to take the place of the glands. Areas in which lymphatic glands occur in other birds and in mammals have been examined in detail, and plexuses have been demonstrated in some of these areas. Such plexuses are particularly noticeable since the occurrence of lymphatic plexuses is comparatively rare in the fowl. In regions such as the skin, plexuses are scarcely ever present, and it is only on the courses of the lymphatics of the abdominal viscera that they are at all plentiful. Where two or more lymphatics are pursuing a common course, they are often united to one another by successive transverse or oblique anastomotic branches, but these can hardly be considered to be plexuses.

Thus, in the domestic fowl, the lymphatic system consists solely of an arrangement of lymphatic vessels which has several communications with the venous system in the anterior thoracic region. With very few exceptions the lymphatics follow the courses of the blood vessels, being closely applied to the walls of these vessels. It has been found that where an artery and a vein have a common course outside the body cavity, the lymphatics usually follow the vein, but if the courses of a corresponding artery and vein are widely separated, lymphatics follow both blood vessels. Within the body cavity, the lymphatics mainly follow the arteries. Two lymphatics usually follow an artery or vein, but a single vessel may be observed. (In most of the appended illustrations the lymphatics are shown as single vessels for the sake of clarity.) Although the main lymphatics have regular courses, it must be emphasised that the tributaries are subject to some variation, as in all animals.

Valves are present in the lymphatics of the fowl, but are relatively few in number and appear to be rather loosely arranged. They are, however, efficient in preventing retrograde flow, as demonstrated when attempts were made to produce a retrograde injection of the thoracic ducts and other large lymphatics.

In his publication, Baum[3] gave definite names to some of the main lymphatic trunks, but it is felt that the lymphatics can best be indicated by the names of the arteries or veins which they follow, without introducing any additional nomen-

clature. Baum considers that each thoracic duct consists of two parts—a "Ductus thoracicus thoracalis," corresponding to the thoracic duct in mammals, and a "Ductus thoracicus lumbalis," lying in the abdominal cavity by the side of the aorta, which, according to Baum, represents the cisterna chyli of mammals. This description seems to be rather artificial, and the term "thoracic duct" is only applied to the large lymphatic vessels lying within the thorax.

The terminology of Kaupp[9] is used as far as possible in this description, since his is the only really detailed statement in English on the anatomy of the fowl.

(1) The Lymphatics of the Head and Neck (Figs. 1, 2 and 3)

The main lymphatic trunks which drain the head and neck follow the two jugular veins and are formed by the confluence of lymphatics following the anterior and posterior cephalic veins at the junction of the head and neck. The lymphatics following the posterior cephalic vein only drain lymph from the bones forming the roof of the cranium, the remainder of the head being supplied by vessels which follow branches of the anterior cephalic vein. A detailed description of the latter vessels cannot be given here, but the following points of interest may be mentioned. One of the tributaries of the lymphatics following the anterior cephalic vein drains the inferior maxilla and the skin of the intermaxillary space, and this tributary exhibits a regular, well-defined plexus on its course, close to its termination. This plexus lies deep to the inferior maxilla, between the pterygoid muscles and the lateral wall of the pharynx, and may possibly represent the submaxillary lymphatic glands of the mammal. Another plexus which is constantly present lies on the course of lymphatics following the transverse vein. These vessels connect the lymphatics following the anterior cephalic veins close to their terminations. The plexus lies between the œsophagus and the cervical musculature, and it is possible that it represents the pharyngeal lymphatic glands of the mammal.

The lymphatics following the jugular vein, usually two in number, lie dorsal and ventral to the vein. In their course down the neck, these lymphatics receive branches at regular intervals from the skin of the neck. Other tributaries include lymphatics draining the muscles on the lateral and inferior aspects of the neck, draining the thymus, which lies superficial to these vessels, and draining the skin of the crop. The lymphatics on the right side of the neck also receive several branches from the dorsal wall of the cervical œsophagus. At the lower part of the neck the lymphatics following the jugular vein run deep to the region of the shoulder joint, where they are joined by tributaries which drain the muscles around the shoulder joint and the proximal extremities of the humerus and clavicle. Other branches include lymphatics following the subscapular vein, lymphatics following the vertebral vein and common carotid artery, responsible for the drainage of the cervical vertebræ and muscles, and a vessel which drains the thyroid gland. The lymphatics on the right side receive branches from the right wall of the crop and from the thoracic œsophagus, while those on the left are joined by the common trunk of vessels which drain the ventral wall of the cervical œsophagus, the left wall of the crop and the whole of the trachea. This branch runs diagonally across the middle line, between the trachea and the cervical musculature, to reach the main trunk of the left side just in front of the thyroid gland.

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The main lymphatics run into the thorax on the lateral wall of the thoracic œsophagus. They terminate by joining the jugular vein just in front of the point at which the vein joins the subclavian vein to form the anterior vena cava. Where two or more lymphatics are present, they usually form a single trunk before joining the vein. If they remain separate, their junctions with the vein are close together.

(2) The Lymphatics of the Wing (Figs. 2, 4, 4A, 5, 5A and 5B)

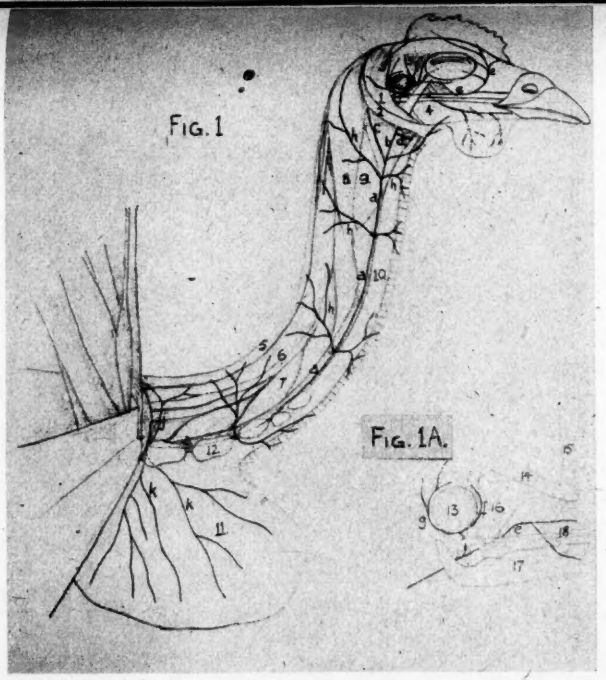
Most of the lymphatics draining the pectoral region are included under this heading.

In the manus and forearm the main lymphatic trunks follow the profunda ulnaris, profunda radialis and basilic veins.

The lymphatics following the profunda ulnaris vein commence on the external surface of the 3rd digit, receiving branches from the skin, bones and articulations in this region. The vessels pass through the interosseous space between the 2nd and 3rd metacarpal bones to reach the internal surface of the wing. At this point they receive tributaries from the skin on the inner aspect of the 2nd digit. Having drained the upper ends of the metacarpal bones and the carpal bones, the main lymphatics run straight up the forearm, along the anterior border of the flexor carpi ulnaris muscle. In their course they are joined by lymphatics from the inner side of the 1st digit, from the carpus, from the lower end of the ulna, from the skin on the inner aspect of the upper and lower thirds of the forearm and from the surrounding muscles. The lymphatics terminate by joining the vessels following the basilic vein, proximal to the elbow-joint and anterior to the origin of the flexor carpi ulnaris muscle.

The lymphatics following the profunda radialis vein arise from the lower end of the radius. They run up the inner aspect of the forearm, between the radius and the flexor digitorum profundus muscle in the early part of their course. Later, they lie deep to the pronator longus muscle and receive branches from the radius and the surrounding muscles. Distal to the elbow-joint, these trunks become superficially placed once more by curving between the pronator brevis and extensor metacarpi radialis longior muscles. At this point they are joined by tributaries which drain the skin and some of the muscles on the outer aspect of the forearm, and pass through the radio-ulnar interosseous space to gain the inner side of the wing. The main trunks then run over the inner aspect of the tendon of insertion of the biceps muscle and are joined by a vessel which drains the flight membrane and the skin on the inner side of the middle third of the forearm. Running vertically upwards, the main lymphatics end by joining the vessels following the basilic vein proximal to the elbow-joint and proximal to the termination of the lymphatics following the profunda ulnaris vein.

The lymphatics following the basilic vein commence in the skin on the anterior border of the outer side of the 2nd digit. They run upwards and backwards and receive tributaries from the outer sides of the 1st and 2nd digits. They come to lie on the inner surface of the wing by curving around the back of the carpal joint, being joined at this point by a branch from the ulna. In the forearm, these trunks lie on the ulna behind the flexor carpi ulnaris muscle. Their tributaries are mainly from the skin and muscles of the forearm. Distal to the elbow-joint, the lymphatics following the basilic vein curve sharply



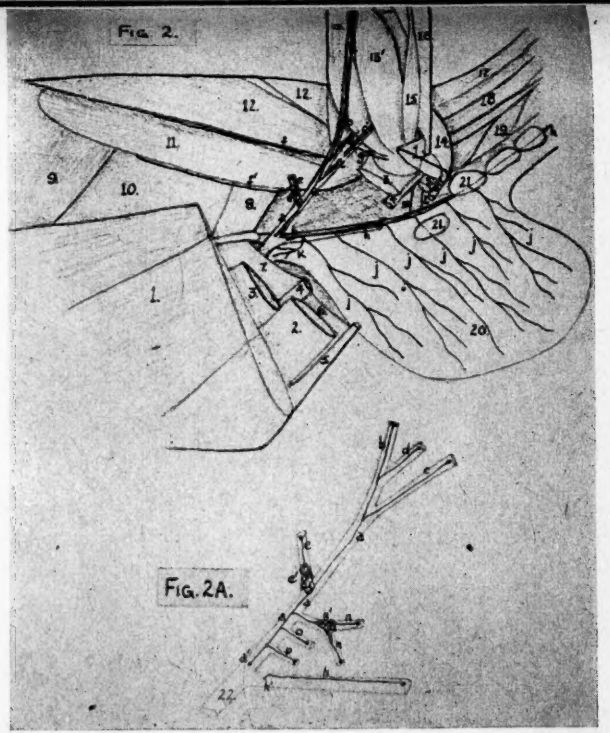


FIG. 1. Superficial lymphatics of right side of head and neck.

FIG. 1a. Diagram to show relations of lymphatics in region of temporo-maxillary joint.

a.—L. following V. jugularis. b.—L. following V. cephalica anterior. c.—L. following V. cephalica posterior. d.—L. following V. transversa. e.—L. following V. facialis cutanea. f.—L. following V. palpebralis. g.—L. following V. temporalis. h.—L. draining skin of neck. j.—L. draining skin over shoulder joint. k.—L. draining skin over crop. 1.—M. biventer maxillæ. 2.—M. genio-hyoideus. 3.—M. temporalis. 4.—M. masseter. 5.—M. biventer cervicis. 6.—M. longus colli posticus. 7.—M. obliquus colli. 8.—M. complexus. 9.—M. rectus capitis lateralis. 10.—Œsophagus. 11.—Crop. 12.—Lobe of thymus gland. 13.—External auditory meatus. 14.—Zygomatic process of squamous temporal. 15.—Supraorbital process. 16.—Quadrate. 17.—Inferior maxilla. 18.—Malar.

FIG. 2. Lymphatics of right side of anterior thoracic region. (M.m. pectoralis major, pectoralis secundus, pectoralis tertius and tensor patagii brevis partly removed. Corroid, clavicle and interclavicular aponeuris partly removed. Some tributaries of L. following V. subclavia omitted).

FIG. 2a. Diagram to show terminations of lymphatics of wing, thoracic wall and head and neck.

a.—L. following V. subclavia. a^1.—Termination of a. b.—L. following V. basilica. c.—L. following V. brachialis. d.—L. following V. profunda humeri. e.—L. following V. cutanea abdomino-pectoralis. e^1.—Plexus on course of e. f.—L. draining M. latissimus dorsi, which joins d. f^1.—L. draining M. terses et infraspinatus. g.—L. draining shoulder joint. h.—L. following V. jugularis. h^1.—Termination of h. j.—L. draining wall of crop. k.—L. draining anterior two-thirds of thoracic œsophagus. 1.—L. from M.m. at proximo-lateral part of arm. m.—L. following V. subscapularis. n.—L. following V. thoracica externa. n^1.—Plexus on course of n. o.—L. following V. coracoidea. p.—L. following V. sternalis. 1.—M. pectoralis major. 2.—M. pectoralis secundus. 3.—M. pectoralis tertius. 4.—Coracoid. 5.—Clavicle. 6.—Interclavicular aponeurosis. 7.—M. subclavius. 8.—M. thoraco-scapularis. 9.—M. serratus magnus anticus. 10.—Thoracic wall. 11.—M. teres et infraspinatus. 12.—M. latissimus dorsi. 13.—M. triceps. 13^1.—M. biceps. 14.—M. tensor patagii brevis. 15.—M. tensor patagii longus. 16.—Elastic ligament at edge of flight membrane. 17.—M. biventer cervicis. 18.—M. longus colli posticus. 19.—M. obliquus colli. 20.—Crop. 21.—Lobes of thymus gland. 22.—Anterior vena cava.

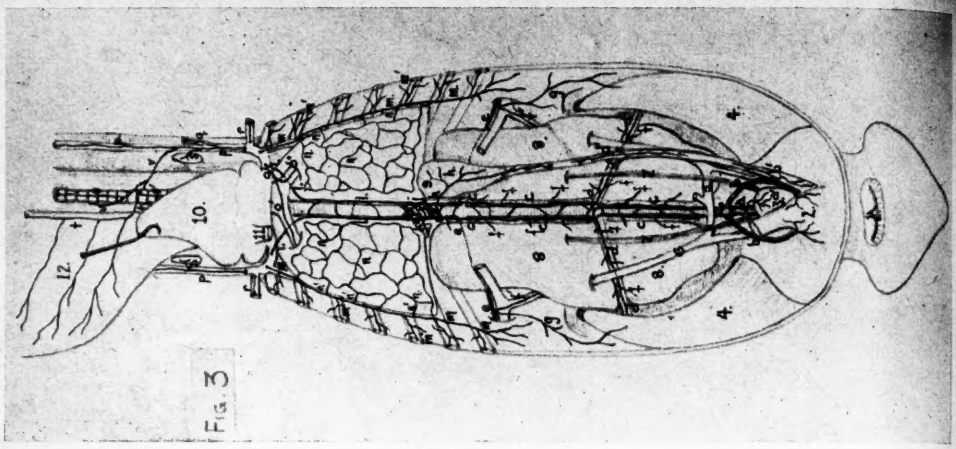


FIG. 3. Lymphatics of trunk. Most of alimentary system removed. Parts of posterior vena cava and V.v. iliacæ communes removed. Heart retracted.
a.—L. following A. sacralis media. a^1.—Tributary of a. b.—L. following A. pudenda communis. b^1.—Tributary of b. from posterior third of oviduct. c.—L. following abdominal aorta. d.—L. following A. ischiadica. d^1.—Tributary of d. from middle third of oviduct. e.—L. following A. cruralis. f.—L. draining kidney. f^1.—L. draining kidney which follow V. iliaca interna. g.—L. following A. epigastrica. h.—L. draining ovary and anterior third of oviduct. j.—Plexus formed by L. following abdominal aorta, anterior mesenteric artery and cœliac axis. k.—L. draining adrenal gland. l.—Thoracic ducts. m.—L. following A. thoracica interna. m^1.—Tributaries of m. from ribs and intercostal muscles. n.—Network of superficial L. of lungs. n^1.—L. draining n. o.—Common trunk of deep L. of lungs. o^1.—L. following V. pulmonis dextra. o^{11}.—L. following V. pulmonis sinistra. p.—L. following V. jugularis. q.—L. following V. vertebralis. r.—L. following V. subclavia. s.—L. draining thyroid gland. t.—L. draining ventral and left surfaces of œsophagus and left surface of crop. u.—L. draining trachea. v.—Common trunk of t. and u. 1.—Cloaca. 2.—Rectum. 3.—Bursa Fabricii. 4.—M. obturator internus. 5.—Anastomosis between V.v. iliacæ internæ. 6.—V. iliaca interna. 7.—Ureta. 8.—Kidney. 9.—Ovary. 10.—Heart. 11.—Posterior vena cava. 12.—Crop.

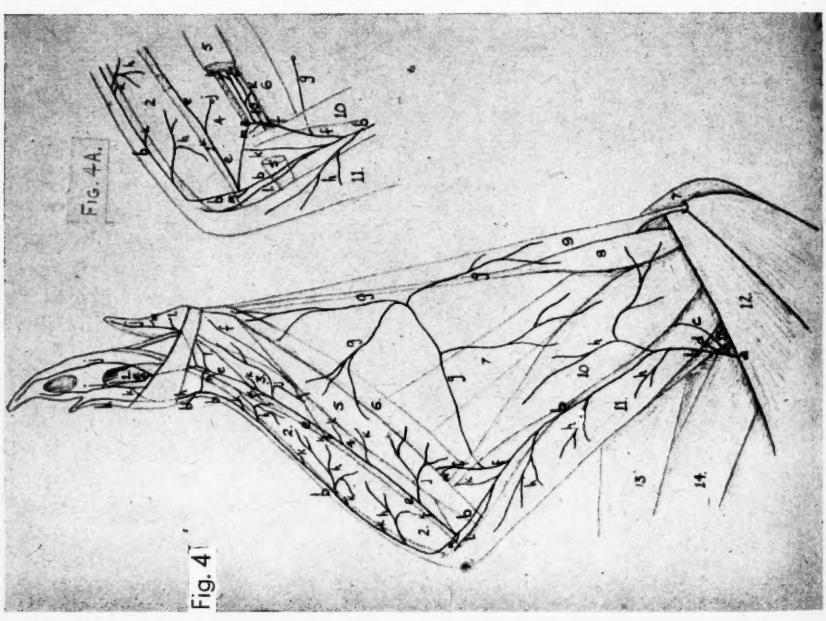


FIG. 4. Superficial lymphatics of inner side of right wing.
FIG. 4a. Part of course of lymphatics following profunda radialis vein. (M.m. pronator longus partly removed).
a.—L. following V. subclavia. b.—L. following V. basilica. c.—L. following V. brachialis. d.—L. following V. profunda humeri. e.—L. following V. profunda ulnaris. f.—L. following V. profunda radialis. g.—L. of flight membrane. h.—Cutaneous tributaries of b. j.—Cutaneous tributaries of e. k.—L. draining muscles. l.—L. draining articulations. m.—L. draining bones. n.—Tributary of f. from outer surface of forearm. 1.—M. interosseous palmaris. 2.—M. flexor carpi ulnaris. 3.—M. flexor digitorum profundis. 4.—M. pronator longus. 5.—M. pronator brevis. 6.—M. extensor metacarpi radialis longior. 7.—M. tensor patagii brevis. 8.—M. tensor patagii longus. 9.—Elastic ligament at edge of flight membrane. 10.—M. biceps. 11.—M. triceps. 11^1.—Long head of 11. 12.—M. pectoralis major. 13.—M. latissimus dorsi. 14.—M. teres et infraspinatus. 15.—M. supinator brevis.

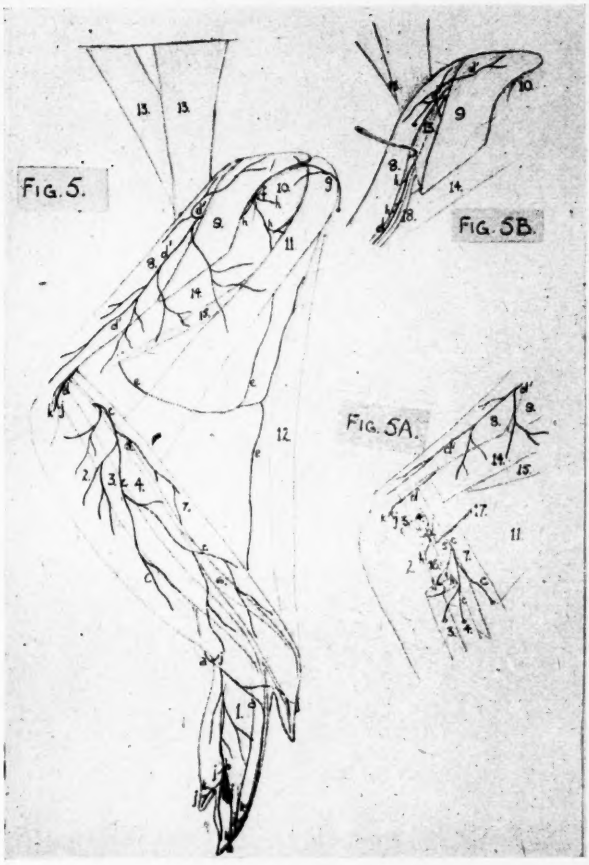


FIG. 5. Superficial lymphatics of outer surface of right wing.

FIG. 5a. Part of course of lymphatics following profunda radialis vein. (M.m. flexor metacarpi radialis and extensor digitorum communis partly removed).

FIG. 5b. Part of course of lymphatics following profunda humeri vein. (M. triceps retracted).

a.—L. following V. basilica. b.—L. following V. profunda ulnaris. c.—Cutaneous tributaries of L. following V. profunda radialis. d.—L. following V. profunda humeri. d^1.—Cutaneous tributaries of d. e.—L. of flight membrane. f.—L. draining M.m. at proximo-lateral part of arm, which join L. following V. jugularis. g.—Cutaneous tributary of L. following V. jugularis. h.—L. draining muscles. j.—L. draining bones. k.—L. draining articulations. 1.—M. interosseous dorsalis. 2.—M. anconeus. 3.—M. flexor metacarpi radialis. 4.—M. extensor digitorum communis. 5.—M. supinator brevis. 6.—M. extensor ossis metacarpi pollicis. 7.—M. extensor metacarpi radialis longior. 8.—M. triceps. 9.—M. deltoideus. 10.—M. scapulo-humeralis. 11.—M. tensor patagii brevis. 12.—Elastic ligament at edge of flight membrane. 13.—M. latissimus dorsi. 14.—Humerus. 15.—M. biceps. 16.—Radio-ulnar interosseous space. 17.—Radius. 18.—N. brachialis longus superior.

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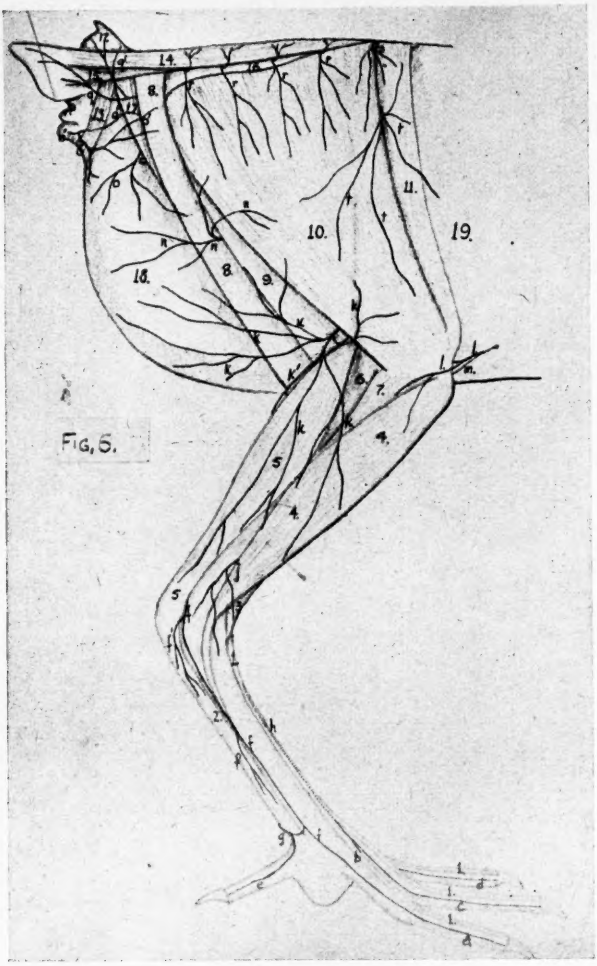

FIG. 6. Superficial lymphatics of abdominal wall, pelvic region, coccygeal region and outer surface of right leg.
a.—L. of lateral surface of 4th digit. b.—L. of medial surface of 4th digit. c.—L. of lateral surface of 3rd digit. d.—L. of lateral surface of 2nd digit. e.—L. of lateral surface of 1st digit. f.—L. following V. metatarsalis externa. f^1.—Cutaneous tributaries of f. g.—Anastomosis between L. following V.v. metatarsalis externa and metatarsalis interna. h.—L. following tributary of L. following V. metatarsalis dorsalis profunda. j.—Cutaneous tributaries of L. following V. tibialis anterior. k.—Cutaneous tributaries of L. following V. poplitealis. k^1.—Branch of k. draining skin on medial surface of leg. l.—Cutaneous tributaries of m. m.—L. following V. cutanea abdomino-pectoralis. n.—L. following V. cutanea abdominalis femoralis. o.—L. following V. cutanea pubica. o^1.—Tributaries of o. o^{11}.—L. draining ventral lip of cloaca. p.—L. draining dorsal lip of cloaca which join L. following V. coccygea. q.—L. following V. cutanea caudalis. q^1.—Tributary of q. r. and s.—Cutaneous tributaries of L. following abdominal aorta. t.—Cutaneous tributaries of L. following V. femoralis anterior. 1.—Tendons of M. extensor digitorum longus. 2. Podothecal sheath of flexor tendons. 3.—M. tibialis anticus. 4.—M. peroneus longus. 5.—M. gastrocnemius. 6.—M. flexor perforatus indicus secundus pedis. 7.—M. flexor perforatus medius secundus pedis. 8.—M. semitendinosus. 9.—M. biceps flexor cruris. 10.—M. gluteus primus. 11.—M. sartorius. 12.—M. femoro-caudalis. 13.—M. transversus perinei. 14.—M. levator coccygis. 15.—M. levator caudæ. 16.—Innominate bone. 17.—Uropygial gland. 18.—Abdominal wall. 19.—Thoracic wall.

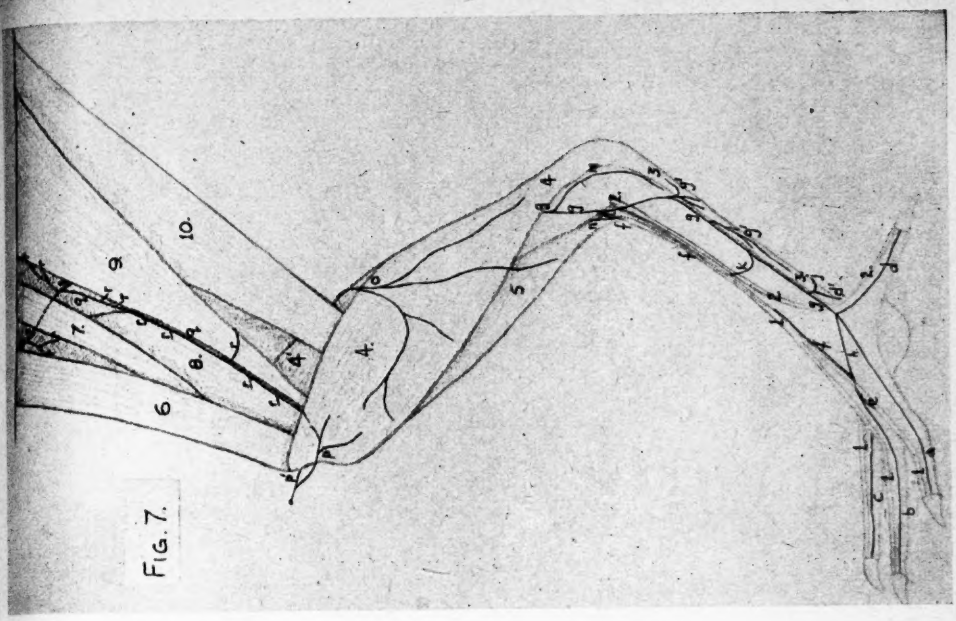

FIG. 7. Superficial lymphatics of inner surface of right leg.
a.—L. of medial surface of 2nd digit. b.—L. of medial surface of 3rd digit. c.—L. of medial surface of 4th digit. d.—L. of medial surface of 1st digit. d^1.—L. of lateral surface of 1st digit. e.—L. of lateral surface of 2nd digit. f.—L. following V. metatarsalis dorsalis profunda. g.—L. following V. metatarsalis interna. g^1.—Cutaneous tributaries of g. h.—Anastomosis between L. following V.v. metatarsalis dorsalis profunda and metatarsalis interna. j.—Anastomosis between L. following V.v. metatarsalis interna and metatarsalis externa. k.—L. following V. metatarsalis dorsalis interna. l.—Terminal branch of f. m.—L draining upper end of metatarsal bone. n.—L. following V. tibialis anterior. o.—Cutaneous tributaries of L. following V. popliteals. p. and p^1.—Cutaneous tributaries of L. following V. cutanea abdomino-pectoralis. q.—L. following V. femoralis interna profunda. r.—L. draining muscles. s.—L. following V. popliteals on medial side of femur. t.—L. draining upper end of femur. 1.—Tendons of M. extensor digitorum longus. 2.—M. extensor hallucis brevis. 3.—Podothecal sheath of flexor tendons. 4.—M. gastrocnemius (inner head). 4^1.—M. gastrocnemius (outer head). 5.—M. tibialis anticus. 6.—M. sartorius. 7.—M. ambiens. 8.—M. vastus internus. 9.—M. semimembranosus. 10.—M. semitendinosus.

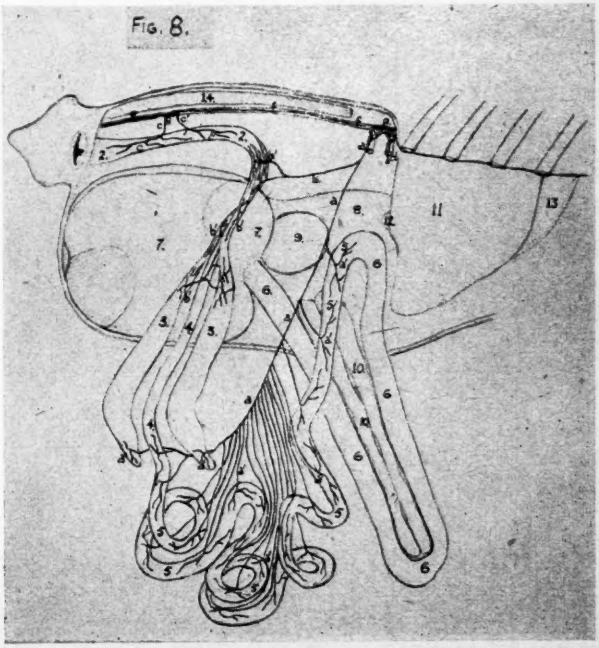

FIG. 8. Lymphatics following anterior and posterior mesenteric arteries. (Viscera viewed from right side and from below). a.—L. following A. mesenterica cranialis. a^1.—Tributaries of a. from jejeunum, ileum and cæca. b.—L. following A. recurrens ileo-cœliacus. b^1.—Tributaries of b. c. and c^1.—L. following A. mesenterica caudalis, of which c^1. does not follow artery in mesentery. d.—L. following cœliac axis. e.—L. following A. sacralis media. f.—L. following abdominal aorta. g.—Plexus formed by L. following abdominal aorta, anterior mesenteric artery and cœliac axis. 1.—Cloaca. 2.—Rectum. 3.—Cæca. 4.—Ileum. 5.—Jejeunum. 6.—Duodenum. 7.—Gizzard. 8.—Proventriculus. 9.—Spleen. 10.—Pancreas. 11.—Liver. 12.—Gall Bladder. 13.—Heart. 14.—Kidney.

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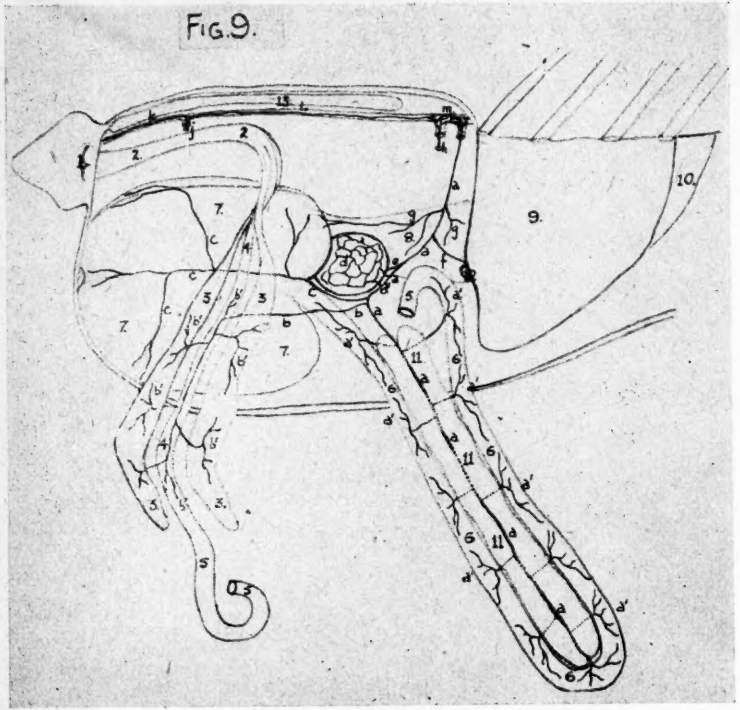

FIG. 9. Lymphatics following cœliac axis. (Most of jejeunum removed. Duodenum drawn forwards. Viscera viewed from right side and from below.)

a.—L. following cœliac axis. a^1.—Tributaries of a. from duodenum. b.—L. following A. recurrens ileo-colicus. b^1.—Tributaries of b. c.—L. draining right surface and dorsal border of gizzard. d.—Plexus in splenic capsule. d^1.—L. draining d. e.—L. draining left surfaces and ventral borders of gizzard and posterior half of proventriculus. f.—L. draining right lobe of liver. g.—L. draining right surface and dorsal border of posterior half of proventriculus. h.—L. following A. mesenterica cranialis. j.—L. following A. mesenterica caudalis. k.—L. following A. sacralis media. l.—L. following abdominal aorta. m.—Plexus formed by L. following abdominal aorta, anterior mesenteric artery and cœliac axis. 1.—Cloaca. 2.—Rectum. 3.—Cæca 4.—Ileum. 5.—Jejeunum. 6.—Duodenum. 7.—Gizzard. 8.—Proventriculus. 9.—Liver. 10.—Heart. 11.—Pancreas. 12.—Gall Bladder. 13.—Kidney.

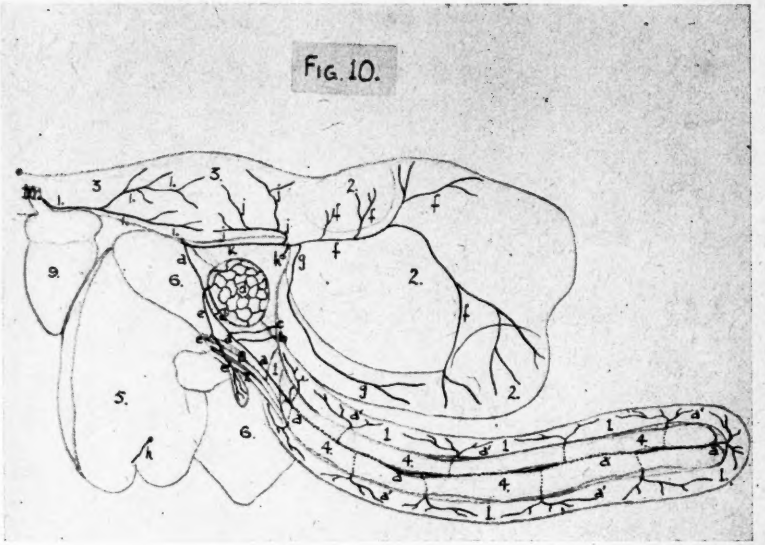

FIG. 10. Lymphatics following cœliac axis. (Left lobe of liver drawn forwards. Viscera viewed from left side and from below).

a.—L. following cœliac axis. a^1.—Tributaries of a. from duodenum. b.—L. following A. recurrens ileo-colicus. c.—L. draining right surface and dorsal border of gizzard. d.—Plexus in splenic capsule. d^1.—L. draining d. e.—L. draining right lobe of liver. e^1.—Tributary of e. from wall of gall bladder. f.—L. draining left surface of gizzard. g.—L. draining ventral border of gizzard. h.—L. draining left lobe of liver (cut). j.—L. draining left surface and ventral border of posterior half of proventriculus. k.—Common trunk of f., g., h. and j. l.—L. following V. proventricularis communis. 1.—Duodenum. 2.—Gizzard. 3.—Proventriculus. 4.—Pancreas. 5.—Left lobe of liver. 6.—Right lobe of liver. 7.—Cystic duct. 8.—Hepatic duct. 9.—Heart. 10.—Left anterior vena cava.

forwards and run parallel with the inner edge of the triceps muscle. Proximal to the elbow-joint, the lymphatics receive branches from the joint and the adjacent muscles and the lymphatics which follow the profunda ulnaris and profunda radialis veins.

The lymphatics following the basilic vein are the main trunks in the arm. They lie at first on the inner border of the triceps muscle, but later run on to its medial surface, behind the biceps muscle. They are joined by tributaries from the skin on the inner side of the arm. At the junction of the proximal and middle thirds of the arm the trunks curve backwards across the triceps muscle, being joined by vessels following the profunda humeri vein, which drain the structures on the outer side of the arm. The lymphatics following the basilic vein end on the posterior border of the arm, close to the upper edge of the pectoralis major muscle, by joining the lymphatics following the brachial vein, the resulting vessels following the subclavian vein.

The lymphatics following the brachial vein drain the biceps muscle, the humerus and the shoulder-joint.

The lymphatics following the subclavian vein curve over the upper edge of the pectoralis major muscle to gain its deep face, and, running downwards and backwards, they enter the thorax. On the deep face of the muscle the lymphatics are joined by vessels following the vena cutanea abdomino-pectoralis which drain the skin over the thorax and the skin of the patellar region. This latter vessel carries a wide regular plexus on its course, close to its termination, which may represent some of the axillary lymphatic glands. The remainder of the axillary lymphatic glands are possibly represented by a plexus at the termination of the vessels following the external thoracic vein, which also join the trunks following the subclavian vein. These vessels following the external thoracic vein drain the pectoral muscles. The main lymphatics which follow the subclavian vein end by uniting with the vein itself, close to the point at which the subclavian and jugular veins join to form the anterior vena cava. As in the case of the vessels following the jugular vein, the lymphatics usually form a single trunk before joining the vein.

(3) The Lymphatics of the Leg (Figs. 6 and 7)

In the region of the metatarsus the main lymphatics follow the external metatarsal, internal metatarsal and deep dorsal metatarsal veins. The main tributaries of these metatarsal trunks are lymphatics which drain the tissues of the digits and run along the inner and outer surfaces of the digits.

The lymphatics following the deep dorsal metatarsal vein run up the front of the metatarsus, mainly underneath the tendons of the extensor digitorum longus muscle, and in their course they receive branches from the skin and muscles anterior to the metatarsus and from the metatarsus itself. In front of the intertarsal joint the lymphatics divide into two main branches. One follows the anterior tibial vein, and the other runs upwards and outwards to join the vessels following the internal metatarsal vein.

The lymphatics following the external metatarsal vein run straight up the metatarsal region in the groove between the podothecal sheath of flexor tendons and the outer surface of the metatarsus. They are joined by branches from the skin and from the metatarsal bone. They cross the intertarsal joint by

tricolus. 9.—Liver. 10.—Heart. 11.—Pancreas. 12.—Gall Bladder. 13.—Kidney.

following the outer edge of the gastrocnemius tendon, receiving a branch from the joint, and, having passed between the gastrocnemius tendon and the underlying flexor muscles, end by uniting with the vessels following the internal metatarsal vein.

The lymphatics following the internal metatarsal vein run vertically upwards in the groove between the sheath of the flexor tendons and the inner surface of the metatarsus, receiving branches from the skin. The lymphatics then run over the front of the intertarsal joint, where they are joined by a branch from the joint and one of the terminal branches of the vessels following the deep dorsal metatarsal vein. The main vessels pass beneath the inner edge of the gastrocnemius tendon to join the trunks which follow the external metatarsal vein, the resulting lymphatics accompanying the posterior tibial vein.

The lymphatics following the anterior tibial vein run up the leg on the anterior surface of the tibia, under the cover of the tibialis anticus muscle. In their course, they are joined by branches from the muscles of the leg, from the skin, from the intertarsal joint and from the tibia. The lymphatics reach the posterior surface of the tibia by passing through the lower tibio-fibular arch and are joined by tributaries from the lower end of the tibia and from the adjacent muscles, and by branches which follow the peroneal vein. They end by joining the lymphatics following the posterior tibial vein.

The lymphatics following the posterior tibial vein run up the leg deep to the inner head of the gastrocnemius muscle, between the soleus and flexor perforans digitorum profundus muscles, and receive tributaries from the muscles at the back of the leg. At the proximal extremity of the tibia they become deeply placed between the soleus muscle and the tibia, and end by joining the vessels following the anterior tibial vein, the resulting trunks following the popliteal vein.

The lymphatics following the popliteal vein run vertically upwards and usually exhibit a large plexus on their course as they lie behind the knee-joint. This plexus may represent the popliteal lymphatic glands of the mammal. In the thigh these trunks lie deep to the gluteus primus muscle and follow the posterior surface of the femur. They receive tributaries from the skin of the leg, the thigh and the abdomen, and from the femur. At the lower edge of the adductor magnus muscle the vessels are joined by lymphatics which follow the vena cutanea abdominalis femoralis, which drain the skin of the abdomen and some of the muscles of the thigh. At this point the main vessels curve forwards across the medial surface of the femur, just below its articular head, and are joined by lymphatics following the vena femoralis interna profunda, which arise from the knee-joint and the muscles on the inner side of the thigh. Passing upwards and forwards, the main lymphatics, lying once again under the cover of the gluteus primus muscle, receive branches from the adjacent muscles, the femur and the hip-joint, and terminate by joining the lymphatics following the anterior femoral vein, the resulting trunks following the external iliac vein.

The lymphatics following the anterior femoral vein arise in the skin of the anterior part of the thigh, and, running deeply between the sartorius and gluteus primus muscles, pass upwards and backwards to join the trunks following the popliteal vein.

The lymphatics following the external iliac vein, formed close to the edge

of the gluteus minimus muscle, run upwards and forwards, deep to the muscle, and, having been joined by a branch from the ilium, perforate the abdominal wall at the middle of the lateral edge of the ilium. Their further course lies within the abdominal cavity.

Some of the tissues of the leg are drained by lymphatics following the ischiadic vein. These arise in the obturator externus, gemellus and adductor muscles and run upwards over the pubis and ischium to enter the pelvic cavity by passing through the ischiadic foramen. They are joined by branches from the pubis, the ischium, the femur, the hip-joint and the obturator internus muscle.

(4) The Lymphatics of the Trunk (Figs. 3, 8, 9 and 10)

Plexuses are frequent and extensive on the courses of the lymphatics of the trunk. They are, however, irregular and tend to merge with one another, and, as a result, it is not considered possible to make any detailed suggestions as to the glands which are represented.

The main lymphatic trunks of the abdominal cavity are vessels which follow the aorta. They are formed by the union of lymphatics following the middle sacral and common pudendal arteries.

The lymphatics following the middle sacral artery arise from the muscles and bones of the coccygeal region. They are deeply placed on the under surface of the vertebræ, and are joined by branches from the skin of the uropygium and cloaca. Running dorsal to the cloaca, the main trunks enter the pelvis, where they lie on each side of the middle sacral artery. Within the pelvis they receive, as tributaries, lymphatics accompanying the cutaneous caudal vein, which drain the skin and muscles on the dorsal surface of the uropygium and the uropygial gland, and the cutaneous pubic vein, which drain the skin of the upper part of the abdominal wall, several muscles and the pubis. These tributaries usually form a common trunk before entering the pelvis at the angle between the ischium and the coccygeal vertebræ. Another branch which joins the main trunks following the middle sacral artery arises from the Bursa Fabricii, if this is present. The vessels end by joining the lymphatics following the common pudendal arteries.

The lymphatics following the common pudendal arteries drain the terminal part of the rectum and, in the young bird, the Bursa Fabricii. They are joined by tributaries from the ureter and, in the male, from the vas deferens. In the female, the lymphatics on the left receive vessels from the posterior third of the oviduct.

The lymphatics following the abdominal aorta, usually double but occasionally present as a single trunk, run forwards between the aorta and the kidney, and receive numerous tributaries. Cutaneous lymphatics from the skin over the upper part of the thigh run through foramina in the lumbo-sacral vertebræ to reach the main trunks. Soon after their formation, the main lymphatics are joined by vessels which follow the posterior mesenteric artery and drain most of the rectum. Branches arising from the ureters and, in the male, the vasa deferentia join the main trunks at regular intervals. Several tributaries arise from the kidneys.

At the level of the 9th or 10th lumbo-sacral vertebra, the lymphatics are joined by vessels which follow the ischiadic artery. These, the lymphatics which follow the ischiadic vein in the leg, accompany the artery within the pelvis.

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Passing across the lower surface of the kidney at the junction of its middle and posterior lobes, they receive branches from the kidney and the ureter. In the male they drain the vas deferens, and in the female the left vessels are joined by lymphatics from the middle third of the oviduct.

An extensive lymphatic plexus is present in the capsule of the testicle and this is drained by four or five lymphatics. The most posterior of these vessels, which also drains the epididymis, joins the lymphatics following the aorta.

At the 2nd or 3rd lumbo-sacral vertebra, the main vessels are joined by lymphatics which follow the crural artery. These are the direct continuations of the lymphatics which follow the external iliac vein in the leg. At their entrance to the abdomen they are joined by vessels following the epigastric artery, which drain the abdominal muscles, and vessels following the internal iliac vein, which drain the kidney. Running inwards, the vessels following the crural artery pass dorsal to the kidney to reach the main trunks.

The lymphatics following the aorta end by forming an extensive plexus which surrounds the aorta and extends forwards through the diaphragm into the thoracic cavity. This plexus is reinforced by the plexiform terminations of the lymphatics following the anterior mesenteric artery and the cœliac axis, which join it behind and in front of the diaphragm respectively.

The lymphatics following the anterior mesenteric artery drain the whole of the jejeunum, the blind anterior extremities and the posterior halves of the cæca and the corresponding sections of the ileum. Their plexiform termination is joined by a common trunk of two or three lymphatics which drain the plexus in the capsule of the testicle in the male, while in the female it is joined by branches from the ovary and the anterior third of the oviduct.

The lymphatics following the cœliac axis arise from the loop of the duodenum and from the pancreas which lies in the loop. In their course they receive branches from the anterior halves of the cæca and the corresponding section of the ileum, from the right surface of the gizzard, from the spleen, from the left surfaces of the gizzard and the posterior half of the proventriculus, from the liver and finally from the right surface of the posterior half of the proventriculus.

The plexus which surrounds the aorta is joined by branches from the adrenal glands and, in the male, by lymphatics draining the anterior extremities of the testicles. The plexus itself is drained by the thoracic ducts.

There are usually two thoracic ducts lying one on each side of the thoracic aorta. A single vessel may be present and this may bifurcate at its termination or may remain single for the whole of its course. Such variations occur frequently. In any case, the junction of the thoracic duct or ducts with the venous system is always situated in the anterior vena cava, and not in the jugular vein as is so frequently asserted in the text-books. The ducts themselves are the largest lymphatic vessels in the body, but, even so, rarely exceed 1 mm. in diameter.

The thoracic ducts run forwards on each side of the aorta as far as the 2nd or 3rd thoracic vertebra, where they diverge, each one passing dorsal to the pulmonary artery and vein on its own side to join the anterior vena cava midway between the formation and termination of the vein. In their courses the thoracic ducts receive branches from the skin of the back, which perforate the longissimus dorsi muscle and pass between the heads of the ribs. These

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also drain the thoracic vertebræ and the costo-vertebral joints. At the 3rd thoracic vertebra the left thoracic duct is joined by a vessel from the right surface of the anterior half of the proventriculus and the adjacent part of the thoracic œsophagus. The left surface of the anterior half of the proventriculus is drained by lymphatics which follow the vena proventricularis communis and join the anterior vena cava close to or in common with the left thoracic duct.

The lymphatics draining the lungs may be divided into superficial and deep groups. The deep lymphatics of each lung are drained by vessels which emerge in company with the pulmonary vein, and the lymphatics from both lungs unite to form a trunk which joins the left anterior vena cava close to or in common with the thoracic duct. The superficial lymphatics of the lung form a wide network on its lower face. Vessels emerge from this network at its outer edge and join the lympathics following the internal thoracic artery. These latter vessels commence as branches draining the abdominal muscles and the diaphragm. Running forwards along the outer edge of the lung, they receive the pulmonary lymphatics and branches from the ribs and intercostal muscles. They join the anterior vena cava close to its formation.

The lymphatics of the heart have courses independent of the coronary arteries and veins. They form two main vessels, a left trunk, which drains the left auricle and ventricle and parts of the right auricle and ventricle, and a right trunk, which drains the remainder of the heart. They have a common termination in the right anterior vena cava, close to its junction with the auricle. To reach this point the left trunk runs on the right of the common aorta and the pulmonary artery, while the right trunk runs on the left of these arteries. The two trunks may unite at the root of the pulmonary artery on its anterior face, in which case the resulting vessel follows the course normally occupied by the left trunk.

Acknowledgment

The author would like to express his indebtedness to Mr. H. V. Hughes, B.V.Sc., M.R.C.V.S., D.V.H., for invaluable help, encouragement and constructive criticism throughout the course of this work.

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The above are only a few of the publications consulted, since space does not permit the inclusion of a complete list. Full bibliographies will be found in the papers by Baum (3) and Josifoff (8).

XUM

THE USE OF D.D.T. AGAINST SHEEP KEDS

By G. B. S. HEATH, *Veterinary Laboratory, Ministry of Agriculture, Weybridge.*

DURING field trials of anti-tick sheep dips it was noted that all sheep keds, *Melophagus ovinus* (*Linnæus*), examined on sheep which had been dipped in D.D.T. were either dead or showed signs of D.D.T. intoxication for at least thirty days after dipping. In view of this, the following experiment was carried out to assess the value of D.D.T. as a ked dip.

Six Cheviot hoggs and one Herdwick hogg, one Herdwick ewe, and two Swaledale ewes, all carrying a light infestation of keds, were dipped for thirty seconds in a bath containing 0.5 per cent. D.D.T., prepared from an emulsion supplied by Dr. J. G. Mitchell, of the D.S.I.R., at Teddington. They were then isolated in a small paddock and kept under observation. Twelve live keds were placed in the fleece of each of two dipped sheep on the 5th, 7th, 16th and 28th days after dipping. Thirty-four days after dipping, nine additional sheep very heavily infested with keds were also put into the paddock for a period of two days.

Daily searching for five days after dipping failed to reveal any live keds on the dipped sheep, although many dead ones were present. On the four occasions when live keds were placed on the dipped sheep only dead keds were found on the following day, and only half the keds introduced to the fleece were recovered. While the undipped infested sheep were running with them live keds appeared on the dipped sheep, but in nearly every case these showed signs of D.D.T. intoxication. Two days after the undipped sheep were removed from the paddock only dead keds were found on the dipped sheep, and examinations during the succeeding five days failed to reveal live keds.

From these results it appears that dipping sheep in D.D.T. at a bath concentration of 0.5 per cent. renders the fleece lethal to keds for not less than thirty-six days. Lower concentrations and longer intervals have not yet been investigated.

Engorged keds can live apart from the host for about ten days, and adults generally emerge from the pupæ in about three weeks, so that this dip should completely eradicate keds from any flock, provided that every sheep is dipped within, say, a period of a fortnight, and that the flock is thereafter segregated from ked-infested sheep.

Eradication of keds may not follow dipping during winter months, since in very cold weather emergence of the adult ked from its pupal case may be delayed for more than thirty-six days. But the period of protection may well exceed that now recorded, and in any case a second dipping about a month after the first should suffice for complete eradication of the parasite.

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Clinical Article

EGGS OF FASCIOLA HEPATICA IN AN UNUSUAL SITUATION

By K. C. SUMNER, *Final Year Veterinary Student and Technician in the Department of Parasitology, Glasgow Veterinary College.*

Introduction

EXAMPLES of the occurrence of *Fasciola hepatica* as an erratic parasite do not appear to be very numerous. The following is a report on the finding of eggs of this parasite in the diaphragm of a sheep, killed at the Glasgow Abattoir.

Historical

Authors dealing with Fasciola have made the following statements:—

Monnig[1] states that some of the young flukes that enter the blood stream may become lodged in unusual situations and may even infect the fœtus in pregnant animals, while Parker[2] states that this parasite often penetrates to organs contiguous with the liver.

Bugge (1935)[3] says that flukes in unusual situations reach these positions through penetrating a vein in the liver while searching for a bile duct, and in this way reach the lungs. Or else, while passing through the intestinal wall they may encounter a lymphatic vessel instead of a vein, and may thus be found in a lymph gland.

On the other hand, Shaw[4] says that attempts to secure infestation of the liver by the injection of live flukes into the jugular vein of lambs and the peritoneal cavity of goats gave negative results.

Begg[5] recalls an instance of having found *Fasciola hepatica* in the thigh of a horse.

Lièvre (1932)[6] (quoted by Diss, 1937) cites seven cases of subcutaneous distomatosis in humans, while Diss (1937)[7] reports the finding of *Fasciola hepatica L.* in a sub-mammary tumour in a woman of sixty years of age.

Srivastava (1939)[8] states that in certain cases, usually in unsuitable hosts, the young flukes penetrate through the intestinal wall into the blood vessels of lymph passages, and are carried to distant parts of the body to become erratic parasites. They have been recovered, he says, from blood vessels, lungs, subcutaneous abscesses, ventricles of the brain, and foci in and around the eye, and records an instance of finding *Fasciola gigantica* in the lungs of a goat.

Merrill and Shaw (1942)[10] say that some controversy remains as to the manner in which liver flukes reach the bile ducts, and quote Krull, who states that there is no evidence that in cattle young flukes enter the bile ducts by puncturing the capsule and migrating through the liver tissue as has been reported in sheep.

Merrill and Shaw themselves, however, state that injections of live flukes into the peritoneal cavity showed that the parasite was capable of penetrating the liver capsule.

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Material

The material supplied by the Glasgow Meat Market for examination consisted of the left flank of a sheep showing parts of ribs 6-13, and an area of abdominal wall and diaphragm. As shown in Fig. 1, the abdominal surface of the diaphragm was blackened, as also was a part of the abdominal wall.

Examination

A scraping of the blackened area was taken, and a smear made and examined under the 2/3rd objective. This examination revealed the presence in the smear of oval bodies resembling the eggs of *Fasciola hepatica*. The smear was then examined under the 1/6th objective, and a definite outline round what appeared to be an ovum led to further steps being taken.

A further scraping was subjected to De Rivas' technique, and smears were made and examined microscopically (Fig. 2) for the presence of eggs. These were again found in considerable numbers in the smear, and it was suspected that they were eggs of Fasciola. No operculum could be seen, however, so the coverslip of one of the preparations was subjected to slight pressure in order to remove the operculum, if such existed. This led to the eggs taking the form of an incomplete oval, one end having been detached (Fig. 3), and on further pressure the ovum was seen to flow out of the shell.

These facts added together led to the assumption that these were eggs of Fasciola species, although in the absence of the parasite itself it was impossible to make a definite diagnosis.

It was thought that a degree of peritonitis had existed and that the liver had been adherent to the abdominal wall, also that these eggs might, therefore, be lying in the liver tissue left adhering to the diaphragm during the dressing of the carcase.

In order to prove that the latter was not so, an incision was made in the diaphragm away from the blackened area, and a scraping made of the deeper tissues. De Rivas' technique was again employed and eggs were isolated.

It was now decided to take a block of tissue from the diaphragm and make sections. This done, slides were made and stained by Hæmatoxylin/Eosin. On examination numerous eggs were found lying in the connective tissue of the diaphragm, surrounded by a certain amount of fibrous tissue and also by numerous small lymphocytes, indicating that these eggs had been lying in the tissues for some time. It should be noted here that no liver cells were found in the sections made.

Finally, the eggs were measured, and of a series of measurements the average size of the eggs present was worked out at 64 × 115 u. The 1/6th objective was used for making these measurements. Monnig[1] states that the eggs of *Fasciola hepatica* measure 63-90 × 130-150 u., while those of *Fasciola gigantica* measure 90 × 130 u.

Discussion

Opinion seems to differ widely on the route of migration of Fasciola to the liver. Monnig[1] states that the flukes may reach the liver either via the blood stream or by way of the peritoneal cavity. Bugge (1935)[3] states that the more general route is via the blood stream, and that flukes reach the lungs by penetrating a vein in the liver while searching for a bile duct, or may be found in a

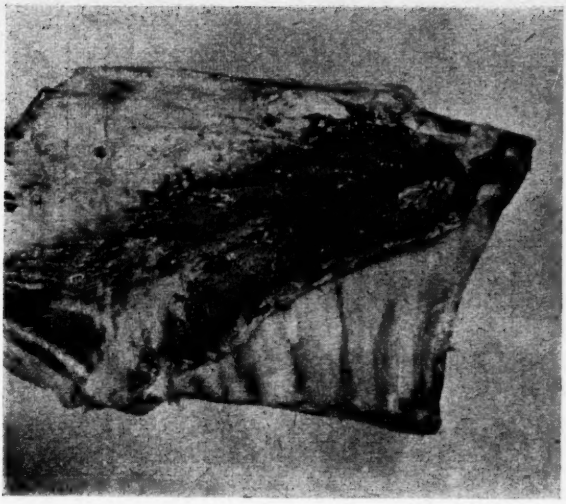

FIG. I.

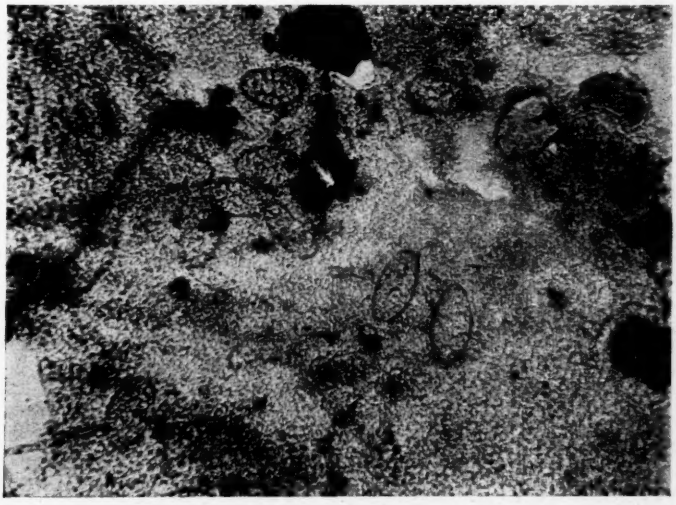

FIG. II. (approx. x 50).

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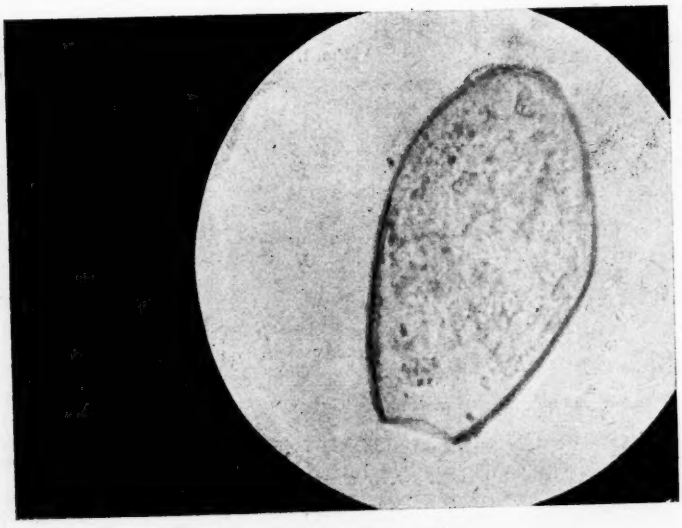

FIG. III. (approx. x 250).

lymph gland following penetration of a lymphatic vessel in the intestinal wall instead of entering a vein.

Krull and Jackson (1943)[9] state that Fasciola may reach its predilection seat by three routes :—

(1) Migration via the hepatic duct.

(2) By the portal circulation.

(3) By migration through the peritoneal cavity.

Shaw (1932),[4] however, describes how in his experiments he recovered 8-30 per cent. of the parasites (fed as cysts to experimental lambs) in the abdominal cavity.

Monnig accounts for the appearance of the parasite in unusual situations by the fact that the young flukes may enter the blood stream.

From these facts three possibilities arise, namely :—

(1) The fluke entered the diaphragm directly from the liver through a peritoneal exudate, due to peritonitis and adhesions.

(2) The fluke gained access to this situation by losing its way when passing through the peritoneal cavity; or

(3) It was carried to the diaphragm by the blood stream.

The chances of the latter being the case seem remote, since the parasite would be carried first via the portal vein to the liver. Bugge (1935) suggests that Fasciola may reach unusual situations by penetrating a vein while wandering in the liver and in this way reach the heart. In this case, however, the fluke would reach the lungs, where it would become encysted and die (Parker).

To reach the diaphragm by this route the young Fasciola would require to pass from the pulmonary arterial circulation to the pulmonary venous circulation, thence via the heart and aorta to the phrenic artery. This would be possible if the parasite were to wander in the lungs as it appears to do when in the liver.

Shaw shows that the flukes may reach their predilection seat by penetration of the intestinal wall, and thence reach the liver by way of the peritoneal cavity. It is therefore possible that in this case one or more flukes lost their way and burrowed into the diaphragm, although no evidence of the parasite other than the eggs was found.

Finally, as already suggested, the parasite may have reached this unusual situation by missing its way while wandering in the liver, and thus reached the diaphragm by passing through a peritonitic exudate, or passing directly from diaphragm to liver if these two organs were adherent.

Due to the fact that only a relatively small area of diaphragm was available for examination, and that the liver was not available at all, it is very difficult to reach any more definite conclusion as to the manner of entrance.

Summary

(1) A blackened area on the abdominal surface of the diaphragm and the abdominal wall of a sheep was received for examination.

(2) Examination revealed the presence of eggs resembling and subsequently proved to be those of Fasciola species.

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(3) The parasite may have reached this situation by one of three routes:—

(a) By the blood stream;

(b) By losing its way in the peritoneal cavity;

(c) By migrating through the liver.

Acknowledgments

The author wishes to thank all who have assisted in any way.

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APPOINTMENTS

MR. J. C. F. FRYER, O.B.E., M.A., has been appointed Secretary of the Agricultural Research Council in succession to the late Dr. Topley. Mr. Fryer has been Director of the Plant Pathological Laboratory of the Ministry of Agriculture and Fisheries for many years, and in addition for the last three years has been acting as Secretary of the Agricultural Improvement Council for England and Wales.

Abstracts from Current Literature

FLUCTUATIONS IN NUMBERS OF TRICHOMONAS FŒTUS*

INITIAL infections, when induced by coitus with infected bulls, resulted in the appearance of trichomonas in the vagina in about one week. Counts ran consistently high for ten days, then the numbers declined gradually, and most cases were negative in eighty days. Early return to estrum was characteristic of all cases that did not develop pyometra, and all during this later period of infection trichomonas were scarce early in the cycle, became abundant two or three days before estrum, and then receded abruptly.

The authors (Hammond and Bartlett, Beltsville, Maryland) believe that when trichomonads do not appear in the vagina until several weeks or months following exposure, then the females involved have been previously infected one or more times. This is also true of females that become pregnant and then abort in two to five months, or else complete the pregnancy uninterrupted.

Initial infection is followed by rapid multiplication in the vagina, cervix and uterus, because these organs are susceptible. This infection induces a resistance in the tissues involved in the course of two or three weeks. Thereafter they no longer support multiplication. The infection in the uterus persists for a longer time, because more time is required to render the uterus resistant, and possibly because the uterus does not always become infected at the time of exposure, but only later as a result of invasion by organisms from the vagina.

Periodic appearance of trichomonads in the vagina in the later stages of infection is due to contraction of the uterus at the onset of estrum, and a consequent discharge of its contents. On this basis, examinations are made to best advantage in from seven to nineteen days following initial exposure, but should be made two or three days before the expected onset of estrum in animals that have been previously infected.

* *American Journal of Veterinary Research*, April, 1945.

BOVINE BRUCELLOSIS: DIFFERENTIAL DIAGNOSIS BETWEEN INFECTED AND NONINFECTED COWS FROM BLOOD PLASMA†

INFECTED and noninfected cows can be differentiated one from another on the basis of bactericidal and growth-inhibiting action of bovine blood plasma or *Brucella abortus*. The group of animals tested by Huddleson contained normal animals and those showing different agglutination titers from a previous natural exposure, or following the injection of a killed *Brucella suis* vaccine.

Blood was collected from the jugular vein by means of a sterile needle into sterile bottles containing 0.1 c.c. of saturated sodium citrate solution for each 10 c.c. of blood drawn. Centrifugal force was used to separate the plasma from the cells. The plasma could then be tested immediately, but there was no interference with the test after storage at 4 degrees C. for as long as ten days.

Live *Br. abortus* was transferred to tubes of fluid medium, and the action of the plasma was measured by the absence of the degree of growth (turbidity) in the tubes, as compared with a control tube inoculated at the same time. Readings

† *Science*, April 6, 1945.

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were made at twenty-four and forty-eight hours. A single smooth strain of *Br. abortus* was used in all experiments, because the use of a rough or dissociated culture showed that growth was inhibited equally by plasma from infected and uninfected animals. The organism multiplied sufficiently so that considerable turbidity was produced in the control tubes, and in those using plasma from infected animals. Plasma samples from immune animals inhibited growth, and the tubes remained clear.

Thus far the growth inhibition test has been found an accurate means of identifying animals infected with *Br. abortus*, whose agglutination titers range from 1:25 to 1:5,000. The test can be developed into routine laboratory procedure.

MAIZE IN THE ETIOLOGY OF PELLAGRA*

THE eating of maize (corn) was associated with pellagra as early as 1735, but it was not until the 1930's that the exact role of that cereal grain in the etiology of pellagra was scientifically demonstrated. Corn is closely associated with the requirement of nicotinic acid, and the feeding of yellow corn actually increases the need for that fraction of the B complex, and therein appears to hinge the explanation of the connection. The investigational work of Krehl, Teply, and Elvehjem, and of Frost and Elvehjem, University of Wisconsin, clearly proved that growth was retarded by adding yellow corn, white corn, or corn grits to the ration of dogs fed on synthetic rations essentially free from nicotinic acid but otherwise adequate. In short, corn is growth-depressing in the absence of sufficient nicotinic acid to overcome that action, for according to the authors, when casein containing 0.005 gm. of nicotinic acid per 100 gm. was increased to 20 per cent. of the ration the growth-depressing action was diminished.

* *Science*, March 16, 1945.

ROLE OF NUTRITION IN EQUINE PERIODIC OPHTHALMIA†

Equine periodic ophthalmia has many characteristics in common with certain eye conditions which, in rats, dogs and man, are known to be caused by riboflavin deficiency. Use of a corneal microscope by Jones, Maurer and Roby at Front Royal, Virginia, reveals microscopic corneal vascularisation in all cases of periodic ophthalmia, with cataract an end point in many cases. The same type of vascularisation of the cornea is the first indication of riboflavin deficiency in rats, dogs and man. In rats, cataract may follow prolonged deficiency. Vascularisation occurs also in rats maintained on a synthetic ration deficient in tryptophane, an essential amino acid; and in animals on a vitamin A deficient diet. The functions of ascorbic acid in the eye are concerned in the periodic ophthalmia syndrome, but it is not yet evident whether the relationship is one of cause or effect.

Nutritional deficiencies in one species cannot be applied unreservedly to another species; but when a nutritive element is required by two species, deficiencies of that element usually result in similar lesions in both species. Vitamin deficiencies are commonly caused by dietary lack, but this is not always the basis of trouble, particularly in marginal deficiency. Several members of the B complex are synthesised by micro-organisms in the intestinal contents, and a change in the activity of these organisms would alter the amount of available vitamins. The amount and quality of the proteins, fats and carbohydrates in the ration may be important.

† *American Journal of Veterinary Research*, April, 1945.

Reviews

The Infectious Diseases of Domestic Animals, with Special Reference to Etiology, Diagnosis and Biologic Therapy. Price $6.00. WILLIAM ARTHUR HAGAN. Comstock Publishing Company, Inc., Ithaca, N.Y.

THIS is an extremely valuable book, written in a style which focuses attention on important details. It is liberally illustrated with most excellent photographs—the microphotographs will prove to be really helpful to both bacteriologists and students.

It is to be expected that diseases occurring in America should receive more prominence than those only encountered elsewhere, and that more references are made to American workers. There is, however, a great deal of information about many diseases which have not been reported in the U.S.A.

In addition to a study of bacterial diseases, there are included those due to fungi, protozoa and viruses. For the student wishing to pursue his studies beyond the scope of this book the essential references are given at the end of each subject.

In the section dealing with the classification of mastitis streptococci the system described is not quite in agreement with that generally adopted in this country.

The amount of information available in this book is such that the volume cannot fail to be useful to veterinary practitioners, laboratory workers, students —post- and undergraduate—and all who are pursuing the study of veterinary bacteriology and medicine. S.L.H.

Lander's Veterinary Toxicology. Revised by J. A. NICHOLSON, M.A., Ph.D., M.R.C.V.S. 3rd Edition, pp. 329. Price 21s. London: Baillière, Tindall and Cox.

THIS third edition of "Lander" follows closely on the lines of the previous ones. Dr. Nicholson has included a number of substances the importance of which from a toxicological point of view has developed or been appreciated within recent years—for example, selenium, molybdenum and phenothiazine. Poisoning by cacao products, which has been frequently encountered, is discussed under food reputed to be poisonous (p. 284). The references, now arranged at the end of each monograph, have been brought up to date, and one is glad to see that the writings of the late Dr. G. W. Clough figure frequently in these. The section on chemical toxicology at the end of the volume describes the general method of analysis originally given by Lander, but references to modern authorities, such as Autenrieth and Bamford, have been incorporated.

In spite of the inclusion of much new material, one misses any reference to the barbiturates (repeatedly met with in "doping" in greyhounds), and to the sulphonamides (whose toxicity in human medicine is well established). There is no mention of the most common form of poisoning by corn cockle (i.e., in young chicks), or of salvaged foodstuffs as a source of lead poisoning. Also one feels, too, that the rat poison zinc phosphide deserves more than a casual mention under zinc (p. 60). On the other hand, is it necessary to repeat *verbatim* from the first

edition the page on iron (p. 71) when the only known case occurred over fifty years ago? One mentions these points in the hope that they will be considered in subsequent editions rather than in the spirit of destructive criticism, for Dr. Nicholson has succeeded in incorporating much up-to-date material of value to the general practitioner, for whom the book is primarily intended, and it can be recommended to all who are interested in the subject. Although the book conforms to the war economy standard, the printing and binding are remarkably good and a credit to the publishers. A.B.O.

Physiology of Farm Animals. By F. H. A. MARSHALL and E. T. HALNAN (1945). Third Edition. Cambridge University Press. Price 18s.

IN order to produce a text-book suitable for students taking a three-year course in agriculture, the authors have attempted to cover a very wide field in one small volume. The book deals mainly with general physiology and subjects related to it, such as energy requirements and feeding standards; there is also a sprinkling of anatomy, histology, genetics and even pathology to be found among its pages.

It will readily be admitted that it is extremely difficult to give a concise account of all these subjects in short compass, and inevitably some of the chapters, as, for example, those dealing with the circulatory system and excretory organs, are somewhat brief; the digestive and reproductive systems are, however, dealt with more fully. It is a pity that in this third edition, old theories which do not agree with present ideas are still to be found. Thus, the accounts of blood coagulation, the regulation of the pyloric sphincter and the emptying of the stomach appear quite misleading. There are also some surprising omissions, for instance, conditioned reflexes are not even mentioned. However, these may be matters of detail which are unimportant to students of agriculture, and, on the whole, the authors have successfully accomplished their object.

From the veterinary reader's point of view, the book is disappointing. The excursions into pathology are unfortunate and the information provided in general physiology is certainly insufficient for students taking the present R.C.V.S. course. Moreover, although numerous authorities are mentioned by name, no references or even dates are given which would enable more advanced students to pursue their studies further. It is, however, one of the few books which contain some information on the special physiology of the fowl, and the chapters on metabolism form a good introduction to the subject. J.A.N.

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